MAGSAT PROGRAM

Progress Report No. 4

Investigation Number M-41

THE REDUCTION, VERIFICATION AND INTERPRETATION OF MAGSAT MAGNETIC DATA OVER CANADA

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I INTRODUCTION

This investigation is primarily concerned with studies of the magnetic field originating in the solid earth, as measured by Magsat. Most of this field originates in the core, but an important part is of lithospheric origin. The magnetic anomalies from the lithosphere are weak, and are easily masked by large effects caused by currents flowing in the ionosphere and magnetosphere, particularly at high latitudes. An important aspect of this study, therefore, concerns the elimination of these effects originating in regions outside the solid earth.

Further refinements of techniques described in earlier reports have allowed the production of improved scalar and vector component anomaly maps for the region north of 40°N latitude.

II TECHNIQUES

During this reporting period the final shipment of CHRONFIN and INVESTIGATOR B tapes were received. Analysis has continued using the INVESTIGATOR B tapes. The technique has been extended to use a statistical screening of individual data points in each grid cell over the map area. The mean value of data for each cell was computed, all data values more than 4nT from the mean were rejected, and the revised mean and standard deviation computed. The average standard deviation for all map grid cells was 1.4nT for the scalar anomaly map and about 2nT for the vector component anomaly maps.

At this stage, the grid cell size is larger and the spatial resolution lower for the vector maps than for the scalar map, because the vector components are considerably more disturbed and more data points were rejected. This technique removes most of the time-varying fields. (Coles et al. 1981).

The data reduction is still only preliminary, because altitude corrections are not yet incorporated. Research into a new approach for altitude adjustments is in progress and will be reported on in due course.

To evaluate the use of scalar and vector Magsat data for the production of regional magnetic charts, comparisons have been made between charts of the north (X), east (Y), Z (vertical) and F (scalar) fields derived from Magsat and those derived primarily from Canadian aeromagnetic data. The satellite data were reduced to sea-level using gradients derived from the field model MGST (4/81). The aeromagnetic data from 1959 to 1976 were also reduced to sea-level and updated to 1980. The data were gridded at 1° intervals of latitude and longitude, and charts contoured. (A rather different gridding procedure from that for the anomaly charts was used). Further details are given in Newitt et al. (1981).

III ACCOMPLISHMENTS

The scalar (F) and vector component (X,Y,Z) anomaly maps are shown in Figs. 1, 2, 3 and 4. Preliminary correlations between anomalies and some major geological features have been observed.

The comparisons between Magsat data and airborne magnetometer data are shown in Fig. 5. Good agreement exists between charts produced from the two data sets. The overall rms difference is 150nT, which is encouraging and is comparable to the fit of the 1980 isogonic chart for Canada to the same aeromagnetic data set.

IV SIGNIFICANT RESULTS

It appears possible to retrieve crustal signals from the horizontal vector components in spite of external disturbance fields at high latitudes.

V PUBLICATIONS

Two papers were presented orally at the 4th IAGA Scientific Assembly in Edinburgh, in August (titles and abstracts were attached to Progress Report No. 2). Updated versions of these papers were submitted to Geophysical Research Letters for inclusion in the special issue on Magsat.

R.L. Coles, G.V. Haines, G. Jansen van Beek, A. Nandi, and J.K. Walker. Magnetic anomaly maps from 40°N to 83°N derived from Magsat satellite data. (submitted to GRL).

L.R. Newitt, E. Dawson, R.L. Coles, and A. Nandi. Magnetic charts of Canada derived from Magsat data. (submitted to GRL).

An abstract for an oral presentation in the session on Geopotential Fields has been submitted to the NASA Geodynamics 4th Annual Meeting.

R.L. Coles: Magsat magnetic anomalies at high northern latitudes: Some relations to earth structure and dynamics.

Abstract

A preliminary scalar magnetic anomaly map for the north polar region (north of 40°N), derived from a subset of Magsat data relative to a field model MGST 4/81, and at average altitude 430 km, shows many magnetic features that can be related to geological provinces, and, in some instances, to active regions of the earth's crust.

Positive magnetic anomalies over some high-grade metamorphic Precambrian terranes contrast with negative anomalies over lower grade Precambrian terranes. Continuations of these anomalies into platform regions suggest the nature of the buried basement in such regions. A positive anomaly is associated with the Aleutian Arc-Trench system, a region of active plate convergence, whereas negative anomaly fields are associated with the Nansen-Gakkel Ridge, a region of plate accretion in the Arctic Basin, with its possible extension into the seismically active Cherskiy Mountains in eastern Siberia, and with the Labrador Sea, an extinct spreading center. However, a weak positive anomaly occurs over Iceland, on the mid-Atlantic spreading ridge system. An intense positive anomaly occurs over the enigmatic Alpha Ridge in the Arctic Basin. Some of these magnetic anomalies are related directly to metamorphic and compositional contrasts in the earth's crust, while others are related to present-day thermal regimes.

VI & VII PROBLEMS AND DATA DELIVERY

We are pleased to have received all the magnetic tapes and products requested. There have, on occasion, been delays resulting from slow delivery and wrongly formatted tapes. However, we realize that providing a large number of tapes to many investigators around the world, with a wide variety of computer systems, is a major task. We appreciate the efforts made on our behalf by the Magsat team and the Goddard Data Center.

VIII RECOMMENDATIONS

Has the Magsat Bulletin ceased publication? Is it that we Investigators need to provide input now?

IX CONCLUSIONS

The statistical screening approach described in section II appears promising in coping with the serious disturbance fields in the horizontal component data. Preliminary comparisons indicate some interesting relations between Magsat anomalies and some major geological features north of latitude 40°N.

FIGURE CAPTIONS

FIGURE 1. Scalar (F) magnetic anomalies from Magsat data, in nanotesla.

FIGURE 2. Vector north (X) component magnetic anomalies from Magsat data, in nanotesla.

FIGURE 3. Vector east (Y) component magnetic anomalies from Magsat data, in nanotesla.

FIGURE 4. Vector vertical (Z) component magnetic anomalies from Magsat data, in nanotesla.

FIGURE 5. Comparison of charts produced from satellite and aeromagnetic grid data. Satellite data (————); aeromagnetic data (••••••••••••); satellite data missing (—— —— ——); aeromagnetic data missing (•• •• •• •• ••).
Contour interval is 1000 nT.

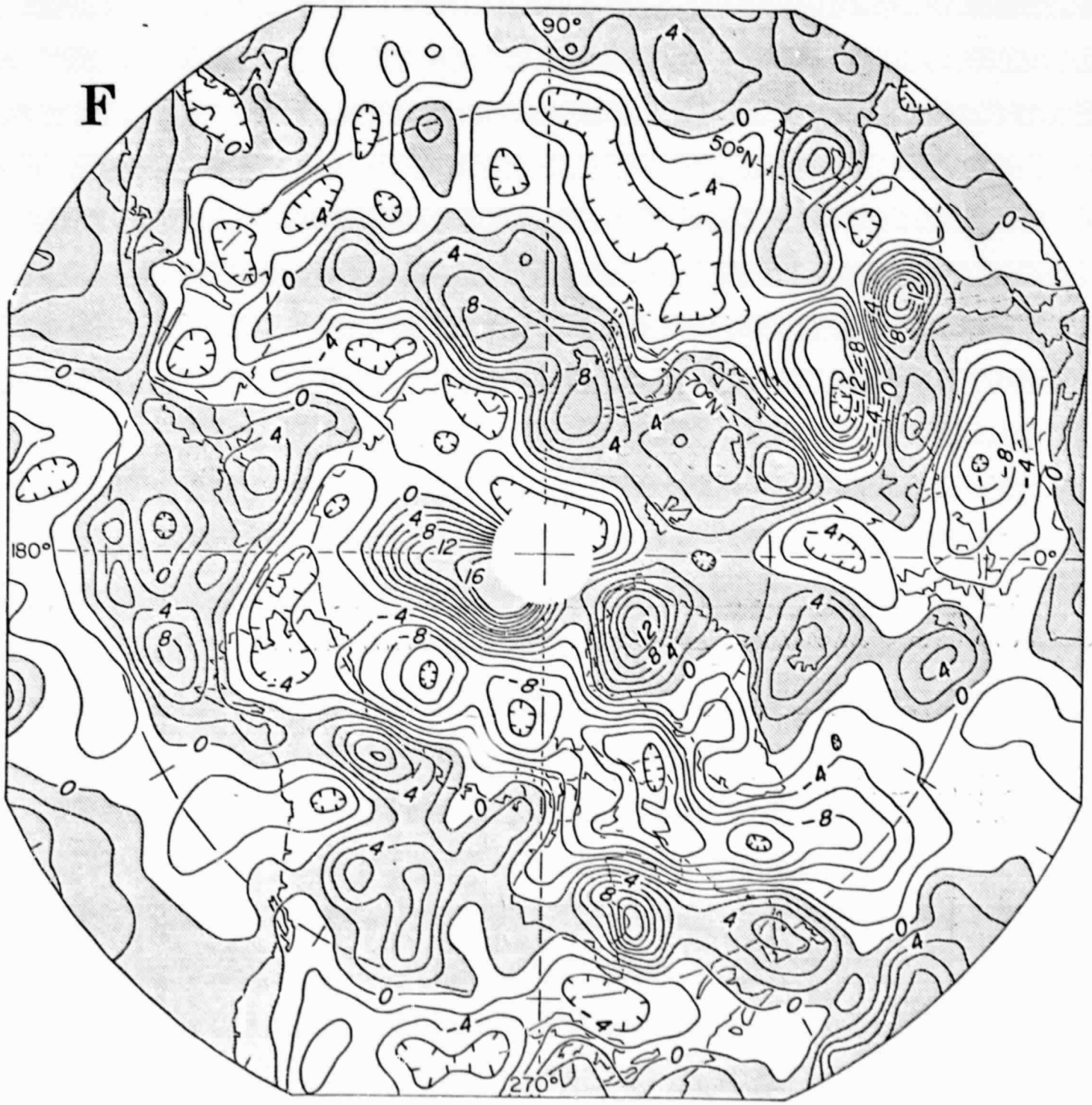

Fig. 1

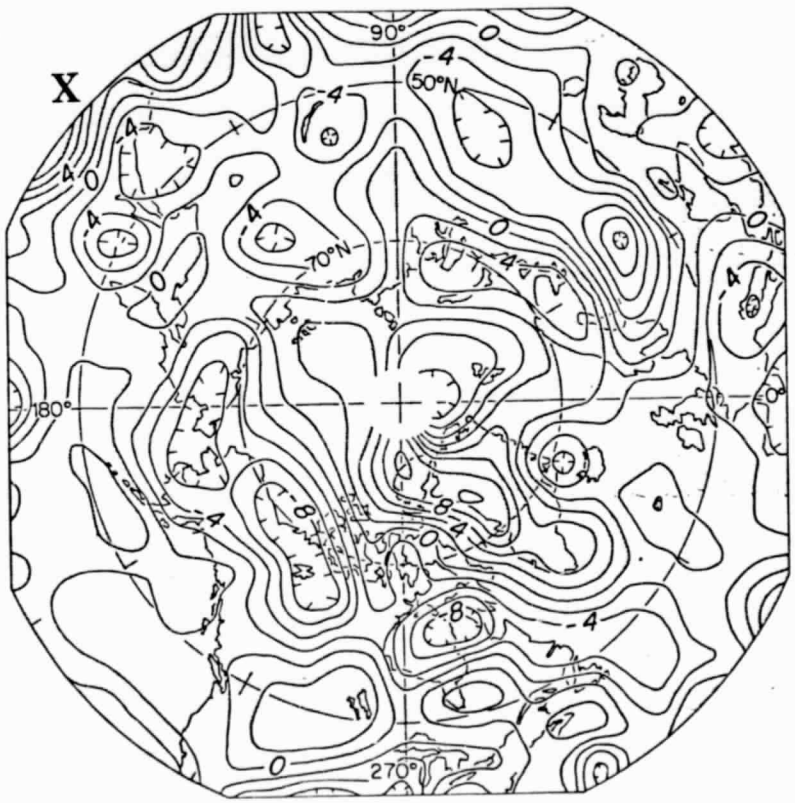

Fig 6

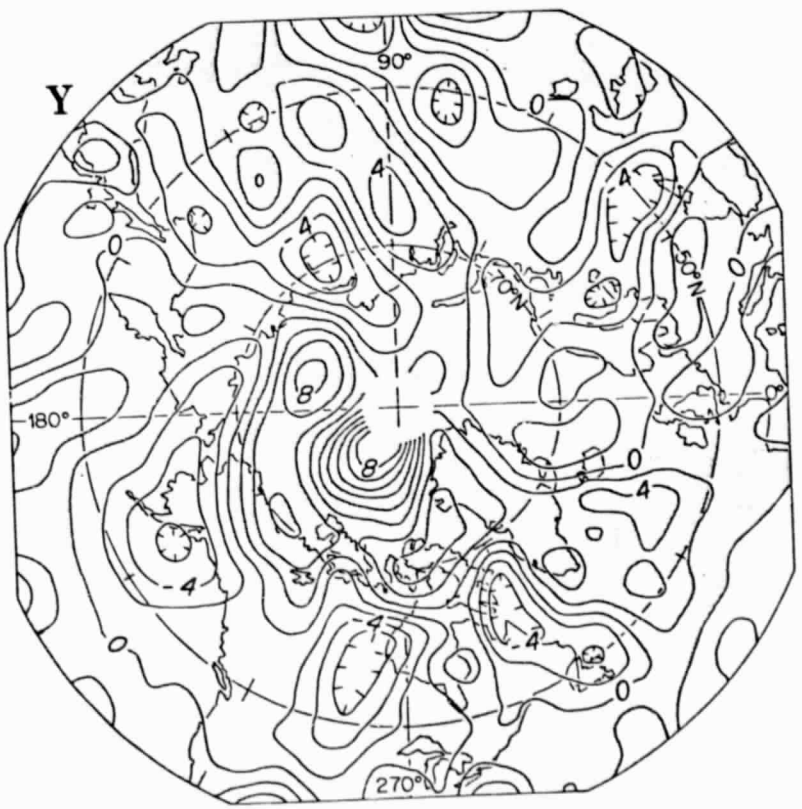

FIG 3

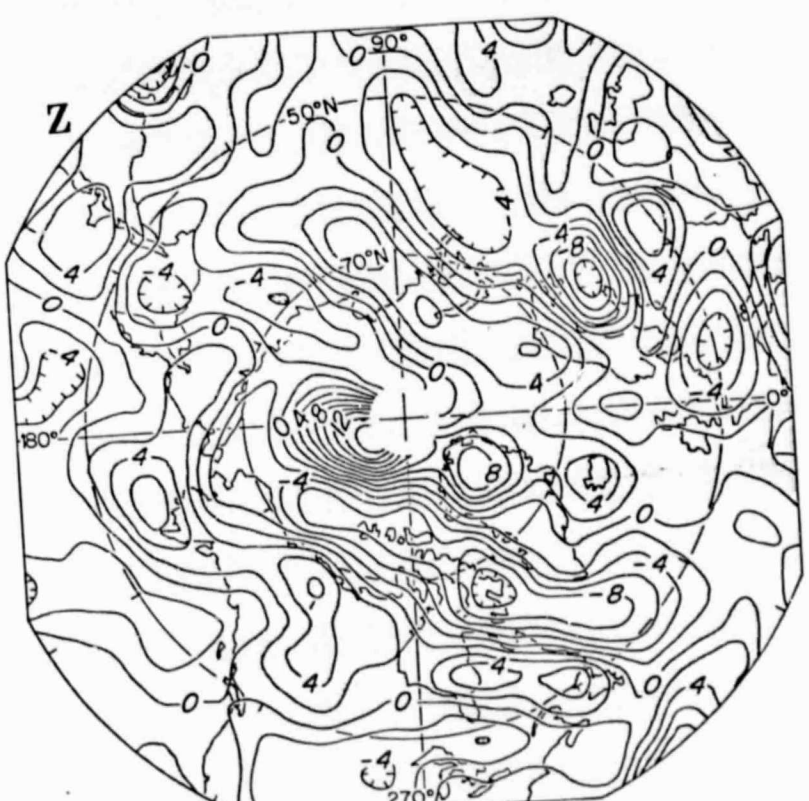

FIG 4

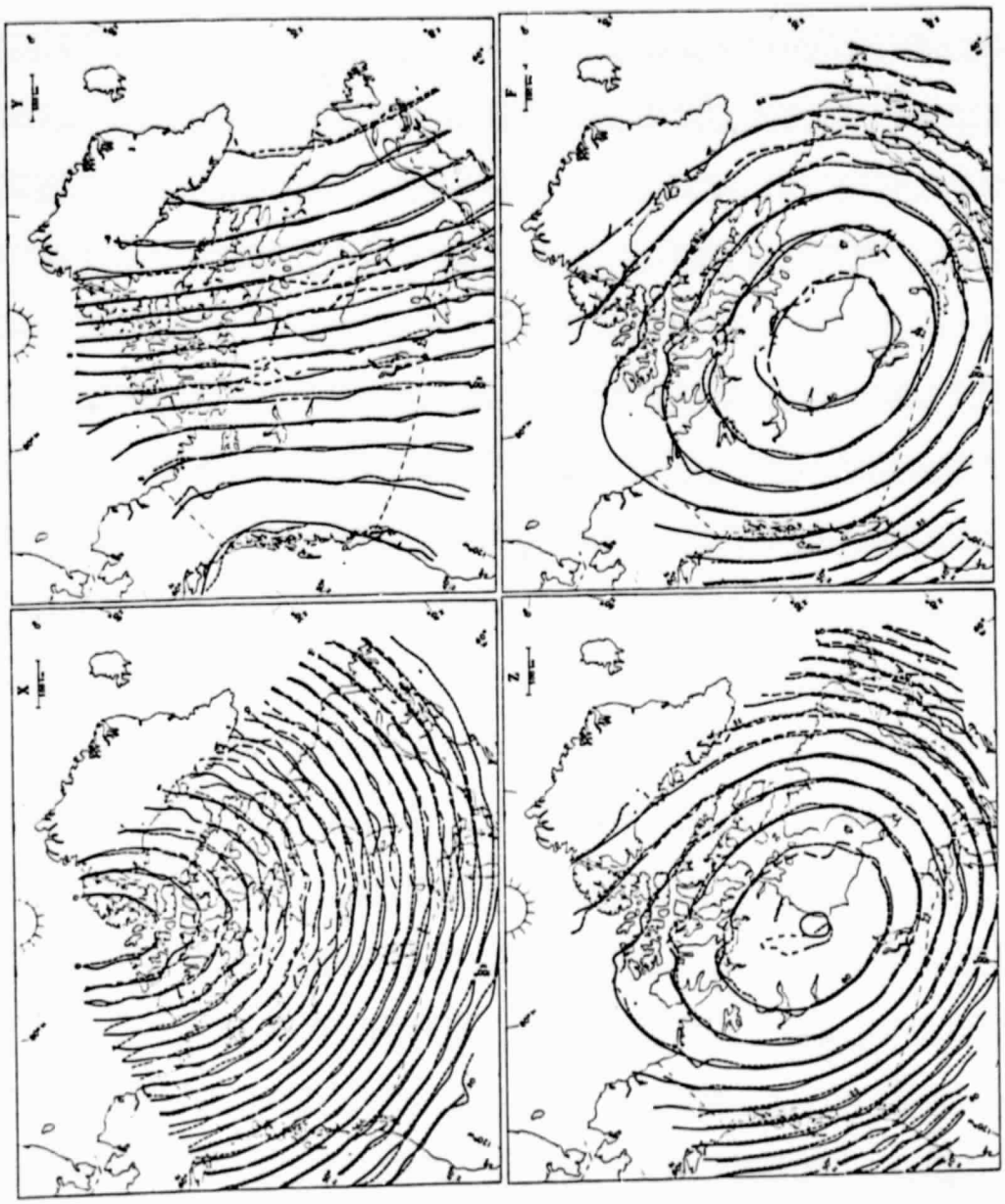

Fig. 5